CHAPTER 3. MARKET AND TECHNOLOGY ASSESSMENT

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CHAPTER 3. MARKET AND TECHNOLOGY ASSESSMENT

3.1 INTRODUCTION

This document presents the market assessment information for the Department of Energy (DOE)'s rulemaking to establish manufacturing standards for commercial unitary air-cooled air conditioners and air-source heat pumps.

Unitary package air conditioning units represent the heating, ventilating, and air-conditioning (HVAC) equipment class with the greatest energy use in the commercial sector in the United States. This equipment is used in 17.2 billion square feet of floor space (about 48 percent of the cooled floor space in the commercial sector). It is responsible for annual energy use of about 0.74 quadrillion British thermal units (quad) of cooling and 0.44 quad of heating.[1] Equipment covered under this rulemaking accounts for the majority of the total shipped tonnage of unitary equipment for commercial building applications.

3.2 MAJOR EQUIPMENT COVERED BY RULEMAKING

The Energy Policy and Conservation Act (EPCA) (42 U.S.C. 6291 et seq., as amended) describes two specific categories of unitary package air-conditioning units: small and large equipment. The small commercial package air conditioning and heating equipment category includes air-cooled, water-cooled, evaporatively cooled, or water source (not including ground water source), electrically operated, unitary central air conditioners and central air-conditioning heat pumps for commercial application with less than 135,000 British thermal units per hour (Btu/h) cooling capacity. The large commercial package air conditioning and heating equipment category includes all the same items, rated at or above 135,000 Btu/h and below 240,000 Btu/h cooling capacity.

This rulemaking is limited to air-cooled package air conditioning and heating equipment rated at or greater than 65,000 Btu/h, but less than 240,000 Btu/h. It does not cover water-cooled, evaporatively cooled, or water-source equipment, nor does it cover equipment with cooling capacities of less than 65,000 Btu/h. There are single package and split system air conditioners and heat pumps within the two categories defined above.

Single package air-conditioning equipment houses all of the components—compressor, condenser and evaporator coils, expansion device, condenser and evaporator fans, and associated operating and control devices—within a single cabinet. In most cases, this package unit is installed on the roof of a commercial building with supply and return air ducts for the building connected directly to the unit to provide conditioning for the building. In most installations, the manufacturer or the contractor in the field incorporates a heating section (typically gas-fired or electric resistance) within the equipment. Figure 3.2.1 shows the typical configuration of a single package air conditioner.[2]

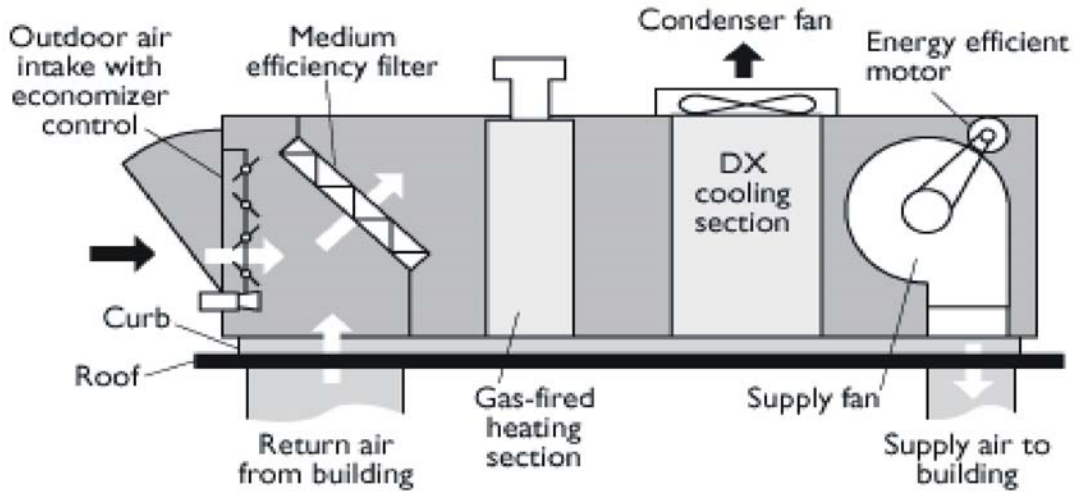

Figure 3.2.1 Single Package Configuration
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In a split system (also referred to as a remote condenser system), the compressor and the condenser coil and fan are together as the condensing unit in a cabinet located outside the building. Refrigerant piping connects the remote condensing unit to the separate indoor cabinet that contains the indoor fan and the evaporator coil and expansion device. Figure 3.2.2 shows the typical configuration of a split system air conditioner[2]

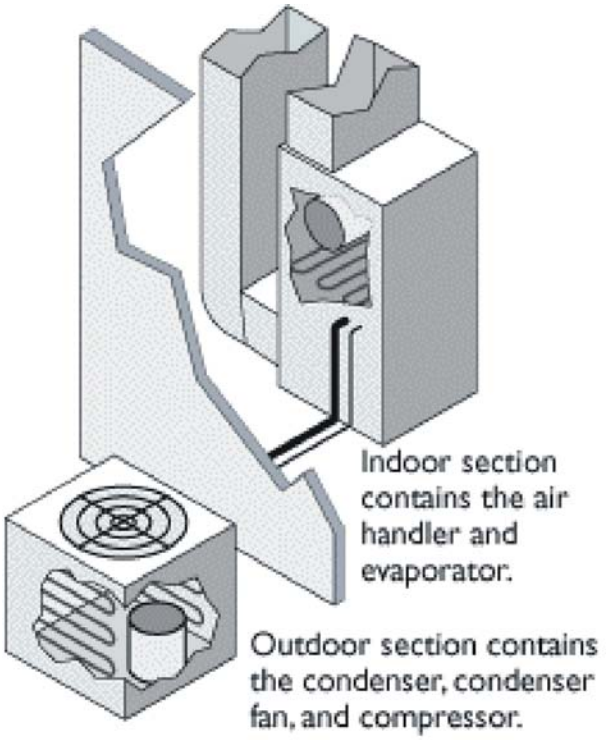

Figure 3.2.2 Split System Configuration
Reprinted with permission from the Idaho Department of Water Resources

The Department has defined four equipment sub-categories for this rulemaking:

- Air-cooled single package and split system unitary air conditioners with a cooling capacity of ≥65,000 to <135,000 Btu/h;
- Air-cooled single package and split system unitary heat pumps with a cooling capacity of ≥65,000 to <135,000 Btu/h;
- Air-source single package and split system unitary air conditioners with a cooling capacity of ≥135,000 to <240,000 Btu/h; and,
- Air-source single package and split system unitary heat pumps with a cooling capacity of ≥135,000 to <240,000 Btu/h.

These categories are further subdivided based on the type of heating section or other attributes. Table 3.2.1 shows the Air-Conditioning and Refrigeration Institute (ARI) classifications of unitary air conditioners and heat pumps and how those classifications relate to the equipment categories established for this rulemaking.

Table 3.2.1 ARI Equipment Types Covered in Rulemaking [3, 4]

Unitary Commercial Product Category	ARI Type Designation	ARI Type	Heat Rejection
Air-Cooled Single Package and Split System Unitary Air Conditioners	Single Package: Air Conditioner	SP-A	Air Cooled
≥65,000 to <135,000 Btu/h	Single Package: Year-Round Air Conditioner	SPY-A	Air Cooled
≥135,000 to <240,000 Btu/h	Split System: Condensing Unit, Coil with Blower	RCU-A-CB	Air Cooled
	Split System: Condensing Unit, Coil Alone	RCU-A-C	Air Cooled
	Split System: Year-Round Condensing Unit, Coil, and Blower	RCUY-A-CB	Air Cooled
Air-Source Single Package and Split System Unitary Heat Pumps	Single Package: Heat Pump	HSP-A	Air Source
≥65,000 to <135,000 Btu/h	Split System: Heat Pump with Remote Outdoor Unit	HRCU-A-CB	Air Source
≥135,000 to <240,000 Btu/h	Split System: With Remote Outdoor Unit, No Indoor Fan	HRCU-A-C	Air Source

3.3 ROLE OF ASHRAE IN DEFINING EQUIPMENT CATEGORIES FOR ANALYSIS

The language regulating this equipment under EPCA specifically requires that DOE consider the efficiency levels promulgated in any updates to Standard 90.1 of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)/Illuminating Engineering Society of North America (IESNA) with respect to these equipment categories. Hence, the starting point for the categorization of the commercial unitary air-conditioning equipment is the most recent revision to ASHRAE/IESNA Standard 90.1.

American National Standards Institute (ANSI)/ASHRAE/IESNA Standard 90.1-1999 (herein referred to as ASHRAE Standard 90.1-1999) provided the most recent update of efficiency levels for the equipment, and prompted this rulemaking. The ASHRAE Standard 90.1-1999 provides minimum efficiency levels for equipment segregated into the five separate equipment categories DOE has chosen for the analysis, as shown in Tables 3.3.1 through 3.3.3.

Table 3.3.1 ARI Designation Description

SP-A	Single Package Air Conditioner, Air Cooled
SPY-A	Year-Round Single Package Air Conditioner, Air Cooled
RCU-A-CB	Split System: Condensing Unit, Coil with Blower, Air Cooled
HSP-A	Single Package Heat Pump, Air Source
HRCU-A-CB	Split System: Heat Pump with Remote Outdoor Unit, Air Source

Table 3.3.2 ASHRAE Standard 90.1-1989 Minimum Efficiency (EER) Levels [5]

Equipment Type	≥65,000 to <135,000 Btu/h cooling capacity	≥135,000 to <240,000 Btu/h cooling capacity
SP-A	8.9	8.5
SPY-A	8.9	8.5
RCU-A-CB	8.9	8.5
HSP-A	8.9	8.5
HRCU-A-CB	8.9	8.5

Table 3.3.3 ASHRAE Standard 90.1-1999 Minimum Efficiency (EER) Levels [6]

Equipment Type	≥65,000 to <135,000 Btu/h cooling capacity	≥135,000 to <240,000 Btu/h cooling capacity
SP-A	10.3	9.7
SPY-A	10.1	9.5
RCU-A-CB	10.3	9.7
HSP-A	10.1	9.3
HRCU-A-CB	10.1	9.3

For this equipment, the incorporation of a non-electric resistance heating section (e.g., gas heating module or hot water coil) results in a 0.2 point energy efficiency ratio (EER) deduction as compared to a similar capacity air conditioner or heat pump with no heating section or with an electric resistance heating section. In fact, the 0.2 point EER deduction is shown as a footnote in ASHRAE Standard 90.1-1999, but is more clearly shown in Tables 6.2.1A and 6.2.1B of the 2001 edition of the ASHRAE Standard 90.1.

For the purpose of this rulemaking, DOE chose not to create separate equipment categories based on the presence and type of heating section. However, DOE used the 0.2 point EER deduction to define the ASHRAE Standard 90.1-1999 baseline efficiency level for equipment with non-electric resistance heating. This clearly applies to the year-round single

package air conditioner, air cooled (SPY-A),[a] and split system year-round condensing unit, coil, and blower, air-cooled (RCUY-A-CB) equipment, which have a gas heating section. In areas where natural gas is readily available, a single package gas heating/electric cooling unit (such as SPY-A) is often the system of choice for commercial building applications. However, DOE uses the 0.2 point EER deduction to define the ASHRAE Standard 90.1-1999 baseline efficiency level for equipment with a heating section other than electric resistance heat. The manufacturer typically installs a gas heating capability in the form of a simple and relatively low-cost component within the cabinet of a cooling-only unit to produce a line of gas heating/electric cooling units.

3.4 EQUIPMENT MANUFACTURERS AND MARKET SHARES

3.4.1 ARI Section Members

The ARI provides "sections" for manufacturers who produce equipment or components of equipment within specified section classifications. One such section is the "Unitary Large Equipment Section" whose equipment scope includes:

1. one piece or matched split system air conditioners and air-source heat pumps with cooling capacities of 65,000 Btu/h and over;

2. condensing units for air conditioning applications with cooling capacities of 65,000 Btu/h and over; and

3. evaporator coils with or without blowers intended for use as a part of a matched split system.

This ARI section includes air conditioners, air-source heat pumps, condensing units, and coils, irrespective of their type of power source or type of refrigeration cycle. Further, this section specifically excludes any equipment included within the scope of another ARI section.[7]

The ARI members with equipment in the unitary large equipment section are: [8]

AAON, Inc.
Carrier Corporation
Dunham-Bush, Inc.
Goettl Air Conditioning, Inc.
Goodman Manufacturing Co.
International Comfort Products
Lennox International, Inc.
Mammoth, Inc.
McQuay International
Mestek, Inc.
Modine Manufacturing Company
Rheem Manufacturing Company
RSI/Typhoon
The Trane Company
York International Corporation

[a] Refers to minimum efficiency levels for single package air conditioner, air cooled (SP-A) and the year-round single package air conditioner, air cooled (SPY-A) equipment shown in Table 3.3.3.

3.4.2 ARI Non-Member Manufacturers

Currently, all domestic equipment covered under this rulemaking are from firms, that are members of ARI.

3.4.3 Current ARI Equipment Manufacturers

The ARI's *Unitary Large Equipment Directory* (January 2002) lists many different domestic manufacturers for this type of equipment. However, consolidation within the industry has reduced the number of parent companies that manufacture similar equipment under different labels. Table 3.4.1 shows the parent company, the associated ARI manufacturer names, and the associated trade-names of equipment covered under this rulemaking.[9]

Table 3.4.1 Domestic Manufacturers with Respective Trade-names

Parent Company	ARI Manufacturer	Trade-name
AAON	AAON, Inc	AAON
Bard	Bard Manufacturing Company	Bard
Carrier	Airquest, Arcoaire, Bryant, Bryant Heating and Cooling Systems-Commercial, Carrier, Carrier Air Conditioning-Commercial, Comfortmaker, Heil, ICP Commercial, Kenmore, Payne Heating And Cooling-Commercial, Tempstar	Airquest, PA Series, PG Series, CHC 3 Phase Series, PH Series, ACC 3 Phase Series, Arcoaire, HCC 3 Phase Series, Bryant, Durapac, Durapac Plus, High Efficiency, Carrier, Centurion, Commercial Heat Pump Weathermaker, Commercial Weathermaker, Gemini, Weathermaker I, Weathermaster, Weathermaster I, Comfortmaker, Heil, Icp Commercial, Kenmore, Kenmore PG Series, Kenmore Ph Series, Kenmore PA Series, Payne, Tempstar
Heat Controller	Century by Heat Controller, Heat Controller, Inc.	Century, Comfort-Aire
Lennox	Armstrong Air Conditioning, Inc., Lennox Industries, Inc.	AAC Commercial, Armstrong, American Aire, Air-Ease, Concord, L Series, Lennox
Mestek	Koldwave	Koldwave Aire-King
Modine	Modine Manufacturing Company	Modine Airsystems AC Series
Nordyne	Frigidaire, Gibson, Grandaire, Nordyne, Inc., Philco, Tappan	Frigidaire P4SM Series, Frigidaire R4GM Series, Gibson P4SM Series, Gibson R4GM Series, Grandaire P4SM Series, Grandaire R4GM Series, Nordyne P4SM Series, Nordyne R4GM Series, Philco P4SM Series, Philco R4GM Series, Tappan P4SM Series, Tappan R4GM Series
Rheem	Rheem Manufacturing Company, Ruud Air Conditioning Division, Weatherking Air Conditioning Division	Rheem 2-RAKA Series, Rheem 2-RALB Series, Rheem RAWD Series, Rheem RAWE Series, Rheem RJKB Series, Rheem RKKA Series, Rheem RKKB Series, Rheem RKMA Series, Rheem RLKA Series, Rheem RLKB Series, Rheem RLMA Series, Rheem RLMB Series, Rheem RPWC Series, Ruud 2-UAKA Series, Ruud 2-UALB Series, Ruud UAWD Series,

Parent Company	ARI Manufacturer	Trade-name
		Ruud UAWE Series, Ruud UJKB Series, Ruud UKKA Series, Ruud UKKB Series, Ruud UKMA Series, Ruud UKMB Series, Ruud ULKA Series, Ruud ULKB Series, Ruud ULMA Series, Ruud UPWC Series, Weatherking 2-WAKA Series, Weatherking 2-WALB Series, Weatherking WAWD Series, Weatherking WJKB Series, Weatherking WKKA Series, Weatherking WKKB Series, Weatherking WKMA Series, Weatherking WKMB Series, Weatherking WLKA Series, Weatherking WLKB Series, Weatherking WLMA Series, Weatherking WLMB Series, Weatherking WPWC
Trane	American Standard, Inc., The Trane Company	F. American-Standard WA, F. Standard, G. American-Standard TA, H. American-Standard, NB. Allegiance 14 - Epact, NC. Allegiance 12 - EPACT, NC. Heritage 12 - EPACT, ND. Allegiance 11 - EPACT, ND. Heritage 11 - EPACT, NE. Allegiance 10 - EPACT, NE. Heritage 10 - EPACT, H. Trane Weathertron, I. Trane, NB. Xl 1400 - EPACT, NC. Xl 1200 - EPACT, NC. Xl 1400 Weathertron - EPACT, ND. Xl 1200 Weathertron - EPACT, NE. XE 1200 - EPACT, NE. XE 1200 Weathertron - EPACT, NF. XE 1100 - EPACT, NF. XE 1100 Weathertron - EPACT, NG. XE 1000 - EPACT, NG. XE 1000 Weathertron - EPACT, NH. Trane Weathertron - EPACT, NH. XB 1000 - EPACT, NI. Trane - EPACT, Trane
York	Airpro, Unitary Products Coleman Evcon Air Conditioning Products - Commercial Coleman, Unitary Products Group Coleman-Evcon, Unitary Products Group Fraser - Johnston, Unitary Products GroupFraser - Johnston, Unitary Products Group - CommercialLuxaire, Unitary Products GroupLuxaire, Unitary Products Group - CommercialYork, Unitary Products GroupYork, Unitary Products Group - Commercial	Airpro, Coleman, CSC LI, Cooler X,Cooler-10, Coleman-Evcon 10, Dayton,HBA Series, ESE Series Fraser-Johnston, HBA Series Luxaire, ERA Series, HRA Series Stellar 2000 (HDB), Embassy Predator, Sunline 2000, Sunline Plus, York

3.4.4 Market Share of Equipment under this Rulemaking

Four of the major companies listed in Table 3.4.1, namely Carrier, Trane, Lennox, and York, hold the majority of the market. These four companies manufacture equipment in all four of the major equipment categories that this rulemaking covers. Two other manufacturers with significant portions of the niche market are AAON and Rheem. The AAON company manufactures high-efficiency SPY-A equipment for sale almost exclusively to large corporate accounts. Rheem produces equipment in each category but mostly smaller capacity models.

Among the six major manufacturers, Carrier dominates the market for commercial unitary equipment, followed by Trane, which has a large share of the market, then Lennox and York, each of whom has a medium share of the market, and finally AAON and Rheem, each with a small but a strong niche market for a specific type of equipment.

3.5 MARKET EQUIPMENT: EFFICIENCY AND CAPACITY RANGE

The ARI's *Unitary Large Equipment Directory* (January 2002) shows that the six major domestic manufacturers of equipment covered under this rulemaking produce units in most of the five ARI equipment types: SPY-A, SP-A, RCU-A-CB, Single Package Heat Pump, Air Source (HSP-A), and Heat Pump with Remote Outdoor Unit, Air Source (HRCU-A-CB). Many of the ARI manufacturers listed have a relatively small range of commercial equipment. For each of these equipment categories, Tables 3.5.1 to 3.5.5 show the six major domestic parent corporations, the ARI manufacturer name, the range of capacities, the EER range, and the number of models available from each of them (as listed in the January 2002 ARI *Unitary Large Equipment Directory*).

Table 3.5.1 Market Information for Year-Round Single Package Air Conditioner, Air Cooled (SPY-A)

Parent Company	ARI Manufacturer Name	Cooling Capacity Range (kBtu/h)	EER Range	Number of Models
AAON, INC.	AAON, INC.	75 to 236	9.1 to 11.6	106
CARRIER	BRYANT HEATING AND COOLING SYSTEMS - COMMERCIAL	71 to 238	8.5 to 11.0	30
CARRIER	CARRIER AIR CONDITIONING - COMMERCIAL	71 to 238	8.5 to 11.6	52
CARRIER	AIRQUEST	72 to 91	9.0 to 9.1	10
CARRIER	ARCOAIRE	72 to 91	9.0 to 9.1	10
CARRIER	COMFORTMAKER	72 to 91	9.0 to 9.1	10
CARRIER	HEIL	72 to 91	9.0 to 9.1	10
CARRIER	ICP COMMERCIAL	72 to 91	9.0 to 9.1	10
CARRIER	KENMORE	72 to 91	9.0 to 9.1	10
CARRIER	TEMPSTAR	72 to 91	9.0 to 9.1	10
LENNOX	ARMSTRONG AIR CONDITIONING, INC.	70 to 238	9.0 to 10.3	17
LENNOX	LENNOX INDUSTRIES, INC.	71 to 238	9.0 to 11.5	25
RHEEM	RHEEM MANUFACTURING COMPANY	72 to 232	8.7 to 10.3	90
RHEEM	RUUD AIR CONDITIONING DIVISION	72 to 232	8.7 to 10.3	90
RHEEM	WEATHERKING AIR CONDITIONING DIVISION	72 to 232	8.7 to 10.3	90
TRANE	AMERICAN STANDARD, INC.	68 to 146	8.9 to 11.3	73
TRANE	THE TRANE COMPANY	68 to 232	8.5 to 11.5	264
YORK	COLEMAN EVCON AIR CONDITIONING PRODUCTS - COMMERCIAL	75 to148	9.0 to 11.5	31
YORK	YORK, UNITARY PRODUCTS GROUP - COMMERCIAL	72 to 232	8.5 to 11.5	46
YORK	FRASER - JOHNSTON, UNITARY PRODUCTS GROUP - COMMERCIAL	72 to 232	8.5 to 11.5	42
YORK	LUXAIRE, UNITARY PRODUCTS GROUP - COMMERCIAL	72 to 232	8.5 to 11.5	42

Table 3.5.2 Market Information for Single Package Air Conditioner, Air Cooled (SP-A)

Parent Company	ARI Manufacturer Name	Cooling Capacity Range (kBtu/h)	EER Range	Number of Models
AAON, INC.	AAON, INC.	76 to 236	9.0 to 11.8	113
CARRIER	CARRIER AIR CONDITIONING - COMMERCIAL	71 to 238	8.5 to 11.6	49
CARRIER	BRYANT HEATING AND COOLING SYSTEMS - COMMERCIAL	71 to 238	8.7 to 11.0	23
LENNOX	ARMSTRONG AIR CONDITIONING, INC.	72 to 238	9.0 to 10.3	13
LENNOX	LENNOX INDUSTRIES, INC.	71 to 238	9.0 to 11.5	25
TRANE	THE TRANE COMPANY	66 to 232	8.9 to 11.6	126
TRANE	AMERICAN STANDARD, INC.	68 to 146	9.0 to 11.3	36
YORK	COLEMAN EVCON AIR CONDITIONING PRODUCTS - COMMERCIAL	72 to 148	9.0 to 11.5	33
YORK	FRASER - JOHNSTON, UNITARY PRODUCTS GROUP - COMMERCIAL	72 to 234	8.5 to 11.5	50
YORK	LUXAIRE, UNITARY PRODUCTS GROUP - COMMERCIAL	72 to 234	8.5 to 11.5	51
YORK	YORK, UNITARY PRODUCTS GROUP - COMMERCIAL	72 to 234	8.5 to 11.5	55

Table 3.5.3 Market Information for Split System: Condensing Unit, Coil with Blower, Air Cooled (RCU-A-CB)

Parent Company	ARI Manufacturer Name	Cooling Capacity Range (kBtu/h)	EER Range	Number of Models
CARRIER	AIRQUEST	74	9	3
CARRIER	ARCOAIRE	74	9	3
CARRIER	COMFORTMAKER	74	9	3
CARRIER	ICP COMMERCIAL	74	9	3
CARRIER	KENMORE	74	9	3
CARRIER	TEMPSTAR	74	9	3
CARRIER	BRYANT HEATING AND COOLING SYSTEMS - COMMERCIAL	69 to 236	8.7 to 11.3	87
CARRIER	CARRIER AIR CONDITIONING - COMMERCIAL	69 to 236	8.7 to 11.3	95
CARRIER	PAYNE HEATING AND COOLING - COMMERCIAL	71 to 120	9.0 to 9.9	14
CARRIER	HEIL	74 to 120	9.0 to 9.1	9
LENNOX	LENNOX INDUSTRIES, INC.	65 to 240	9.0 to 10.2	48
RHEEM	WEATHERKING AIR CONDITIONING DIVISION	67 to 208	8.8 to 10.3	66
RHEEM	RHEEM MANUFACTURING COMPANY	67 to 238	8.8 to 10.3	91
RHEEM	RUUD AIR CONDITIONING DIVISION	67 to 238	8.8 to 10.3	89
TRANE	AMERICAN STANDARD, INC.	65 to 238	8.5 to 12.0	155
TRANE	THE TRANE COMPANY	65 to 238	8.5 to 12.0	106
YORK	AIRPRO, UNITARY PRODUCTS GROUP	72 to 87	9.2 to 9.9	2
YORK	COLEMAN, UNITARY PRODUCTS GROUP	72 to 87	9.2 to 9.9	2
YORK	COLEMAN-EVCON, UNITARY PRODUCTS GROUP	73 to 89	9.3 to 10.0	2
YORK	FRASER - JOHNSTON, UNITARY PRODUCTS GROUP	73 to 89	9.3 to 10.0	2
YORK	LUXAIRE, UNITARY PRODUCTS GROUP	73 to 89	9.3 to 10.0	2
YORK	YORK, UNITARY PRODUCTS GROUP	73 to 89	9.3 to 10.0	3
YORK	LUXAIRE, UNITARY PRODUCTS GROUP - COMMERCIAL	88 to 140	8.9 to 9.5	5
YORK	YORK, UNITARY PRODUCTS GROUP - COMMERCIAL	88 to 238	8.5 to 9.5	9

Table 3.5.4 Market Information for Single Package Heat Pump, Air Source (HSP-A)

Parent Company	ARI Manufacturer Name	Cooling Capacity Range (kBtu/h)	EER Range	Number of Models
CARRIER	AIRQUEST	74	8.9	3
CARRIER	ARCOAIRE	74	8.9	3
CARRIER	COMFORTMAKER	74	8.9	3
CARRIER	HEIL	74	8.9	3
CARRIER	ICP COMMERCIAL	74	8.9	3
CARRIER	KENMORE	74	8.9	3
CARRIER	TEMPSTAR	74	8.9	3
CARRIER	BRYANT HEATING AND COOLING SYSTEMS - COMMERCIAL	68 to 172	8.9 to 10.3	12
CARRIER	CARRIER AIR CONDITIONING - COMMERCIAL	68 to 230	8.9 to 10.5	15
LENNOX	ARMSTRONG AIR CONDITIONING, INC.	72 to 226	9.0 to 11.0	7
LENNOX	LENNOX INDUSTRIES, INC.	72 to 226	9.0 to 11.5	8
RHEEM	RHEEM MANUFACTURING COMPANY	89 to 117	9.2	6
RHEEM	RUUD AIR CONDITIONING DIVISION	89 to 117	9.2	6
RHEEM	WEATHERKING AIR CONDITIONING DIVISION	89 to 117	9.2	6
TRANE	THE TRANE COMPANY	70 to 230	8.9 to 10.6	43
TRANE	AMERICAN STANDARD, INC.	71 to 146	8.9 to 9.4	10
YORK	FRASER - JOHNSTON, UNITARY PRODUCTS GROUP	87 to 222	8.5 to 10.7	11
YORK	LUXAIRE, UNITARY PRODUCTS GROUP - COMMERCIAL	87 to 222	8.5 to 10.7	11
YORK	YORK, UNITARY PRODUCTS GROUP - COMMERCIAL	87 to 222	8.5 to 10.7	11
YORK	COLEMAN EVCON AIR CONDITIONING PRODUCTS -COMMERCIAL	90 to 144	9.3 to 10.7	3

Table 3.5.5 Market Information for Split System: Heat Pump with Remote Outdoor Unit, Air Source (HRCU-A-CB)

Parent Company	ARI Manufacturer Name	Cooling Capacity Range (kBtu/h)	EER Range	Number of Models
CARRIER	AIRQUEST	75	8.9	3
CARRIER	ARCOAIRE	75	8.9	3
CARRIER	BRYANT	75	8.9	3
CARRIER	CARRIER	75	8.9	3
CARRIER	COMFORTMAKER	75	8.9	3
CARRIER	HEIL	75	8.9	3
CARRIER	ICP COMMERCIAL	75	8.9	3
CARRIER	KENMORE	75	8.9	3
CARRIER	TEMPSTAR	75	8.9	3
CARRIER	PAYNE HEATING AND COOLING - COMMERCIAL	86	9.8	1
CARRIER	BRYANT HEATING AND COOLING SYSTEMS - COMMERCIAL	86 to 172	8.8 to 9.8	3
CARRIER	CARRIER AIR CONDITIONING - COMMERCIAL	86 to 172	8.8 to 9.8	3
LENNOX	LENNOX INDUSTRIES, INC.	87 to 112	9.2 to 9.4	12
RHEEM	RHEEM MANUFACTURING COMPANY	92 to 118	9.2 to 9.6	6
RHEEM	RUUD AIR CONDITIONING DIVISION	92 to 118	9.2 to 9.6	6
RHEEM	WEATHERKING AIR CONDITIONING DIVISION	92 to 118	9.2 to 9.6	6
TRANE	AMERICAN STANDARD, INC.	66 to 234	8.9 to 11.0	70
TRANE	THE TRANE COMPANY	68 to 234	9.0 to 11.2	70
YORK	AIRPRO, UNITARY PRODUCTS GROUP	89	9.4	1
YORK	COLEMAN, UNITARY PRODUCTS GROUP	89	9.4	1
YORK	COLEMAN-EVCON, UNITARY PRODUCTS GROUP	89	9.4	1
YORK	YORK, UNITARY PRODUCTS GROUP	89	9.4	1
YORK	FRASER - JOHNSTON, UNITARY PRODUCTS GROUP	121	9	1
YORK	LUXAIRE, UNITARY PRODUCTS GROUP - COMMERCIAL	121	9	1
YORK	YORK, UNITARY PRODUCTS GROUP - COMMERCIAL	91 to 214	8.6 to 9.2	4

3.5.1 Overview of Equipment Availability

A summary of the information in Tables 3.5.1 through 3.5.5 is given below.

Year-Round Single Package Air Conditioner, Air Cooled (SPY-A)

All six major manufacturers market equipment under this category. The equipment covers a broad range of efficiencies (8.5 to 11.6 EER) and cooling capacities (70,000 Btu/h to 238,000 Btu/h). Parent company Rheem makes models that minimally comply with ASHRAE Standard 90.1-1999 efficiency levels. Carrier has a long list of manufacturer names, which appear to market the same models under different brand names (See Table 3.5.1 above).

Single Package Air Conditioner, Air Cooled (SP-A)

Five of the major manufacturers (all except Rheem) market equipment under this category. Rheem does not manufacture single package air conditioners without a gas heating section. The equipment covers a broad range of efficiencies (8.5 to 11.8 EER) and cooling capacities (66,000 Btu/h to 238,000 Btu/h). Lennox manufactures models that minimally comply with ASHRAE Standard 90.1-1999 efficiency levels (See Table 3.5.2 above).

Split System: Condensing Unit, Coil with Blower, Air Cooled (RCU-A-CB)

Five of the major manufacturers (all except AAON) market equipment under this category. The equipment covers a broad range of efficiencies (8.5 to 12.0 EER) and cooling capacities (65,000 Btu/h to 240,000 Btu/h). York and Carrier own many separate manufacturing brands and appear to market the same base model under different brand names. These models are probably derivatives of residential models and, for the most part, do not comply with ASHRAE Standard 90.1-1999 (See Table 3.5.3 above).

Single Package Heat Pump, Air Source (HSP-A)

Five of the major manufacturers (all except AAON) market equipment under this category. The equipment covers a broad range of efficiencies (8.5 to 11.5 EER) and cooling capacities (68,000 Btu/h to 230,000 Btu/h). Heat pump cooling efficiencies appear slightly lower than air conditioner efficiencies based on a review of the January 2002 ARI *Unitary Large Equipment Directory*. None of the Rheem models shown in the 2002 directory meet ASHRAE Standard 90.1-1999 efficiency levels. Lennox is the only parent company with equipment showing EERs of 11.0 or higher (See Table 3.5.4 above).

Split System: Heat Pump with Remote Outdoor Unit, Air Source (HRCU-A-CB)

Five of the major manufacturers (all except AAON) market equipment under this category. The equipment covers a broad range of efficiencies (8.6 to 11.2 EER) and cooling capacities (66,000 Btu/h to 234,000 Btu/h). Rheem, Carrier, and Lennox models do not meet ASHRAE Standard 90.1-1999 efficiency levels. Carrier has a long list of manufacturer names, which appear to market the same models under different brand names. Trane is the only parent

company with equipment efficiency levels meeting or exceeding ASHRAE Standard 90.1-1999 levels (See Table 3.5.5 above).

3.6 HISTORICAL SHIPMENTS AND EFFICIENCIES

3.6.1 Census Data

The *U.S. Census Manufacturing Reports* provide information related to equipment shipments by domestic manufacturers.[10] The reports use cooling capacity ranges expressed in a manner different from those in the present DOE rulemaking. The major classifications presented in the U.S. Census data for single package and split system air conditioners are for cooling capacities 65,000 Btu/h to <135,000 Btu/h and 135,000 Btu/h to 250,000 Btu/h. For heat pumps, U.S. Census data report only shipments of units with cooling capacities greater than 65,000 Btu/h.

Figure 3.6.1 compares the number of units shipped from 1993 to 2000 for split system and single package year-round and non year-round air-conditioning equipment for 65,000 Btu/h to <135,000 Btu/h, split system and single package year-round and non year-round air-conditioning equipment for 135,000 Btu/h to 250,000 Btu/h, and heat pumps for greater than 65,000 Btu/h.

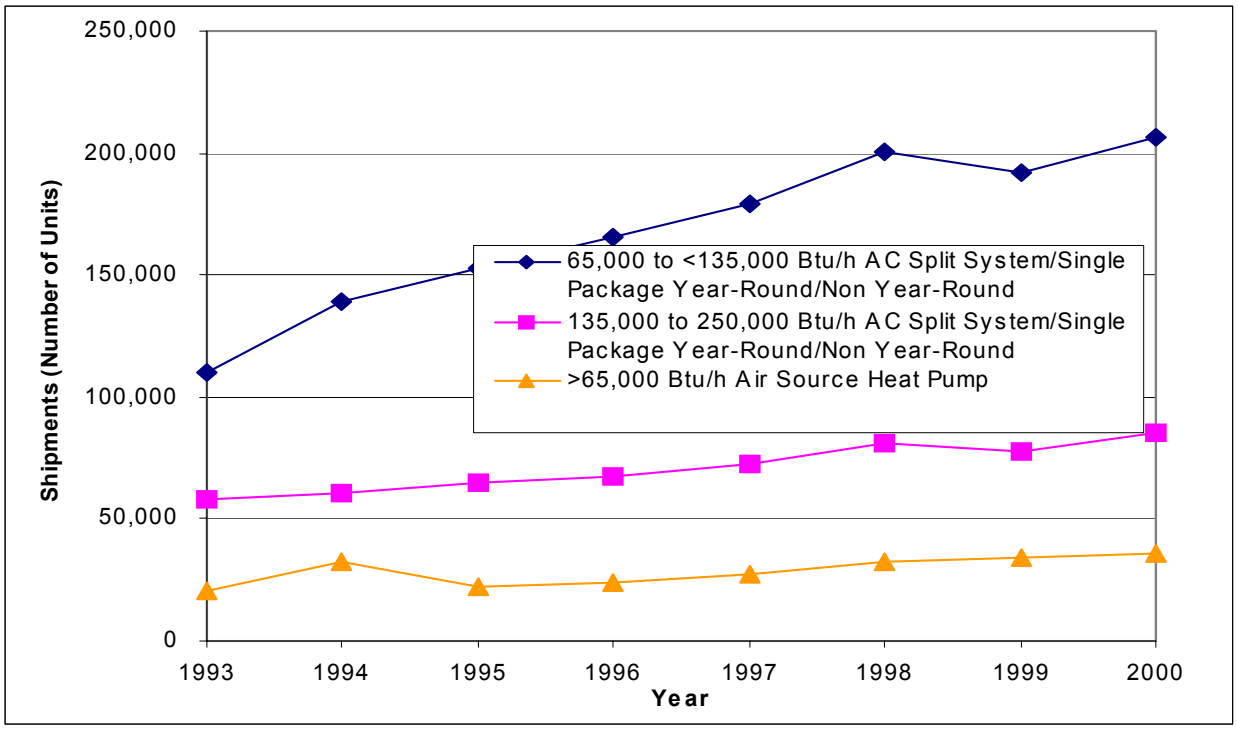

Figure 3.6.1 Number of Units Shipped for Combined Split System and Single Package Air Conditioners and Air-Source Heat Pumps
Source: U.S. Census, 2001

The number of split system and single package air conditioners shipped in the ≥65,000 Btu/h to <135,000 Btu/h cooling capacity range grew approximately 8.1 percent per year while the number of ≥135,000 Btu/h to 250,000 Btu/h cooling capacity equipment shipped grew by approximately 5 percent per year. The number of air-source heat pump units shipped, while numerically much smaller, also grew at an average of 7.1 percent per year, with a brief fall in 1995 and recovery in 1998.

Using the 2001 U.S. Census data, the DOE broke down single package, year-round, and split system air conditioners, and single package and split system heat pumps within their respective capacity ranges. Figure 3.6.2 shows the breakdown by total number of units shipped, and Figure 3.6.3 shows the breakdown by percentage of units shipped.

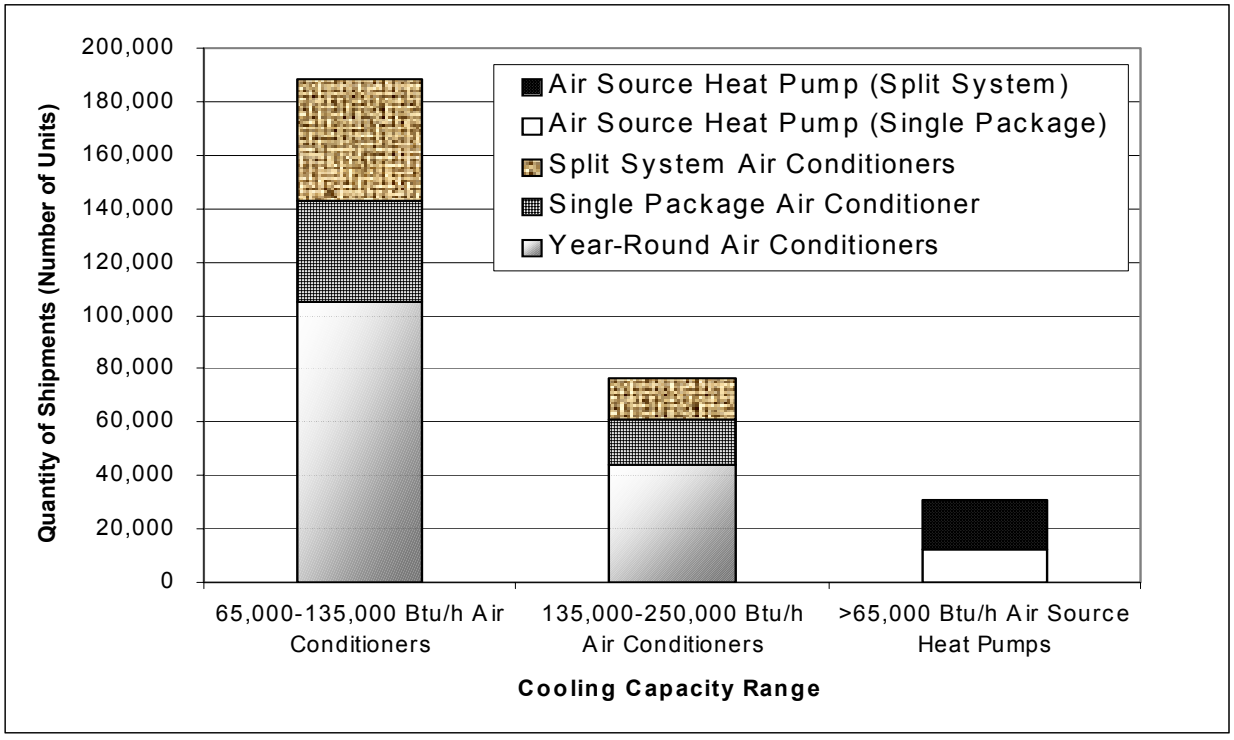

Figure 3.6.2 Year 2000 Total Number of Units Shipped for Large Unitary Equipment Based on Cooling Capacity Range
Source: U.S. Census, 2001

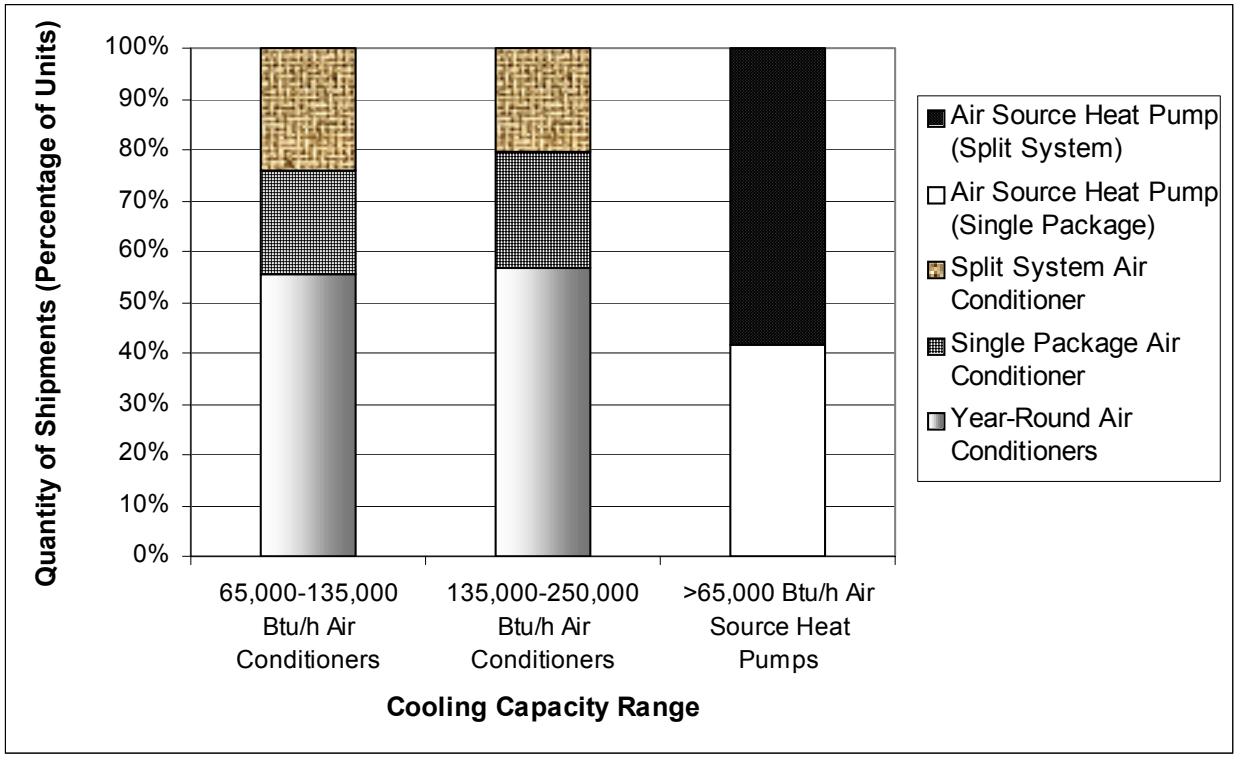

Figure 3.6.3 Year 2000 Percentage of Units Shipped for Large Unitary Equipment Based on Cooling Capacity Range
Source: U.S. Census, 2001

Figures 3.6.2 and 3.6.3 indicate that year-round single package air conditioners (equipment with gas heating sections) account for approximately 50 percent of the market for equipment covered under this rulemaking, and approximately 56 percent of all air-conditioning equipment for both size categories (with heat pumps making up the rest). Split systems account for approximately 23 percent of the market. The remaining 21 percent of the air conditioning market is made up of single package units sold without a heating section. In total, for the equipment under this rulemaking, single package equipment makes up approximately 77 percent and heat pumps make up approximately 10 percent, with heat pumps divided between split systems making up 58 percent, and single package systems making up the remaining 42 percent of the heat pumps. Although the Census data do not provide shipments by size category for this heat pump equipment, data from ARI suggest that 90 percent of heat pump shipments were in the 65,000 Btu/h to 135,000 Btu/h category. Although split systems make up 58 percent of heat pump shipments, they make up only 42 percent of the shipped value. Therefore, it appears the single package units sold tend to be larger and more expensive.

3.7 BASELINE EFFICIENCY AND IMPACT OF BUILDING CODES

3.7.1 Efficiency Links between Building Codes and Federal Legislation

The unitary equipment covered under this rulemaking is also covered under ANSI/ASHRAE/IESNA Standard 90.1 *Energy Standard for Buildings Except Low-Rise Residential Buildings*. While this standard by itself is a voluntary building energy standard, the Energy Conservation and Production Act, 42 U.S.C. 6831 et seq., as amended (ECPA), specifically requires that:

> Whenever the provisions of ASHRAE Standard 90.1-1989 (or any successor standard) regarding energy efficiency in commercial buildings are revised, the Secretary shall, not later than 12 months after the date of such revision, determine whether such revision will improve energy efficiency in commercial buildings. The Secretary shall publish a notice of such determination in the Federal Register.
>
> If the Secretary makes an affirmative determination under subparagraph (A), each State shall, not later than 2 years after the date of the publication of such determination, certify that it has reviewed and updated the provisions of its commercial building code regarding energy efficiency in accordance with the revised standard for which such determination was made. Such certification shall include a demonstration that the provisions of such State's commercial building code regarding energy efficiency meet or exceed such revised standard.

(42 U.S.C. 6833(b)(2)(A) and (B)(i)) The above requirements are separate from the requirement that DOE modify manufacturing efficiency standards for this equipment to meet or exceed the minimum efficiency levels specified in the most recent updated version of ASHRAE Standard 90.1, as explained in EPCA. (42 U.S.C. 6313(a)(6)(A)) The last two versions of the standard are: ANSI/ASHRAE/IESNA 90.1-1999 and ANSI/ASHRAE/IESNA 90.1-2001 published. These two standards are available through ASHRAE "Standards and Guidelines" at http://resourcecenter.ashrae.org/store/ashrae (January 2004). Both are undergoing DOE review.

While these requirements for manufacturing and building energy standards seem to be very similar, several important differences exist in terms of their impact on commercial buildings:

1. The ECPA requirement that States update their building energy standards hinges upon a positive determination of energy savings by DOE. Until DOE makes such a determination, States are under no obligation to update these building energy standard requirements.

2. The ECPA building energy standard requirements do not specifically address each individual component of the standard. Thus, a State may choose not to update the efficiency of a specific class of equipment if it can show that its building standard can meet or exceed the latest update to Standard 90.1-1999 without updates to the equipment section.

3. The requirements under ECPA pertaining to building standards do not necessarily apply to alterations made to existing buildings. A State may choose to apply them to building alterations, but it is not a requirement. Hence, the ECPA building energy standard requirements do not necessarily impact the majority of shipments of the equipment being analyzed, which are shipped to existing buildings.

4. The DOE's ability to enforce the manufacturing standards of these equipment efficiency levels (EPCA requirement) is easier to accomplish than ensuring that higher efficiency equipment is actually installed in individual buildings in compliance with voluntary building energy standards (an ECPA requirement for States to enforce).

5. Even if all States adopted and enforced the ASHRAE requirements for this equipment, the compliance deadline for higher equipment efficiency levels in building energy standards based on ASHRAE Standard 90.1-1999 is different from the compliance deadline for manufacturers (a date that will be determined when the final rule is published).

For these reasons, DOE expects that there will be an increase in the average installed equipment efficiency as a direct result of the propagation of new building energy standards based on ASHRAE Standard 90.1-1999 or ASHRAE Standard 90.1-2001. However, it is unclear how fast that propagation will occur. It is doubtful that it will occur at the same time for all states, based on the past history for state adoption of ANSI/ASHRAE/IES 90.1-1989, which, ten years after passage of the Energy Policy Act (EPAct), is still not a basis for building energy standards in 12 out of the 50 states.

Both ASHRAE Standard 90.1-1999 and ASHRAE Standard 90.1-2001 require that, where new HVAC equipment is a direct replacement for existing equipment, the new equipment (including air conditioners and heat pumps) shall comply with the specific minimum efficiency standards shown in ASHRAE 90.1. However, building inspectors are unlikely to enforce this requirement and, as a result, the ASHRAE Standard 90.1-1999 requirements will impact new construction more than replacement construction.

3.7.2 Manufacturer Equipment Lines and Efficiency Before and After October 2001

The ASHRAE Standard 90.1-1999 lists the efficiency requirements for installation in new or existing buildings as of October 29, 2001. The Department expected that most major commercial unitary equipment manufacturers would offer unitary equipment which meets or exceeds these levels. However, it was generally impossible to know the extent to which their equipment lines would move to the new efficiency levels. This was not necessarily true of the smaller players in the market, and it was not universally true for all equipment categories or capacities either. Several manufacturers appear to be developing newer equipment lines that meet or exceed ASHRAE Standard 90.1-1999 energy efficiency levels (e.g., Lennox L-Series). Certain manufacturers appear to offer key equipment in each line specifically designed to just meet the new ASHRAE Standard 90.1-1999 energy efficiency levels. A comparison of the July 2001 and January 2002 ARI *Large Equipment Directories* underscores this market transition.

Table 3.7.1 summarizes equipment efficiency data from the July 2001 ARI *Unitary Large Equipment Directory* for SPY-A equipment for the six major U.S. manufacturers.[11] Table 3.7.2 summarizes equipment efficiency data from the January 2002 ARI *Unitary Large Equipment Directory* for SPY-A equipment. [10]

Table 3.7.1 July 2001 Efficiency Levels for Year-Round Single Package Air Conditioner, Air Cooled (SPY-A)

Year-Round Single Package Air Conditioner, Air Cooled, ≥65,000 Btu/h to < 135,000 Btu/h

EER	York	Trane	Carrier	Lennox	Rheem	AAON
8.9 ≤ x < 9.3						
9.3 ≤ x < 9.7						
9.7 ≤ x < 10.1						
10.1 ≤ x < 10.5						
10.5 ≤ x < 10.9						
10.9 ≤ x < 11.3						
11.3 ≤ x < 11.7						
11.7 ≤ x <12.1						
12.1 ≤ x < 12.5						
≥12.5						

Year-Round Single Package Air Conditioner, Air Cooled, ≥135,000 Btu/h to < 240,000 Btu/h

EER	York	Trane	Carrier	Lennox	Rheem	AAON
8.5 ≤ x < 8.9						
8.9 ≤ x < 9.2						
9.2 ≤ x < 9.5						
9.5 ≤ x < 9.9						
9.9 ≤ x < 10.3						
10.3 ≤ x < 10.7						
10.7 ≤ x < 11.1						
11.1 ≤ x < 11.5						
≥11.5						

Available Unavailable

Source: ARI, *Unitary Large Equipment Directory*, July 2001

Table 3.7.2 January 2002 Efficiency Levels for Year-Round Single Package Air Conditioner, Air Cooled (SPY-A)

Year-Round Single Package Air Conditioner, Air Cooled, ≥65,000 Btu/h to < 135,000 Btu/h

EER	York	Trane	Carrier	Lennox	Rheem	AAON
8.9 ≤ x < 9.3						
9.3 ≤ x < 9.7						
9.7 ≤ x < 10.1						
10.1 ≤ x < 10.5						
10.5 ≤ x < 10.9						
10.9 ≤ x < 11.3						
11.3 ≤ x < 11.7						
11.7 ≤ x < 12.1						
12.1 ≤ x < 12.5						
≥12.5						

Year-Round Single Package Air Conditioner, Air Cooled, ≥135,000 Btu/h to < 240,000 Btu/h

EER	York	Trane	Carrier	Lennox	Rheem	AAON
8.5 ≤ x < 8.9						
8.9 ≤ x < 9.2						
9.2 ≤ x < 9.5						
9.5 ≤ x < 9.9						
9.9 ≤ x < 10.3						
10.3 ≤ x < 10.7						
10.7 ≤ x < 11.1						
11.1 ≤ x < 11.5						
≥11.5						

Available Unavailable

Source: ARI, *Unitary Large Equipment Directory,* January 2002.

Comparison of Tables 3.7.1 and 3.7.2 shows several significant changes in model availability in a six-month period. A detailed comparison of the 2001 and 2002 directories indicated that in the ≥65,000 Btu/h to 134,999 Btu/h size category, Lennox deleted two of its models from the 9.7 to 10.0 efficiency range, but added one model in the 11.3 EER range. Trane added nine models in the EER of 10.5 to 10.8 range. Carrier also added six models with efficiencies in the 10.1 to 10.5 range. In the larger size category, Trane deleted 12 models in the 8.9 to 9.1 efficiency range. The AAON company deleted 20 models in the 10.3 to 10.7 efficiency range.

Perhaps more importantly, for the six major manufacturers, the July 2001 ARI *Unitary Large Equipment Directory* listed 289 models as "deleted." The January 2002 ARI *Unitary Large Equipment Directory* listed 781 models as "deleted." This means that a total of 492 models were deleted between July 2001 to July 2002. It is not clear whether these "deleted" models have been discontinued or are not being rated any more.

3.7.3 ASHRAE Standard 90.1-1999 Compliance by Manufacturers and Equipment Type as of January 2002

Tables 3.7.3 and 3.7.4 below summarize the availability of five key equipment types for each of the six major manufacturers (York, Carrier, Lennox, AAON, Trane and Rheem), for the two major capacity categories (≥65,000 Btu/h to <135,000 Btu/h and ≥135,000 Btu/h to <240,000 Btu/h) covered by this rulemaking.[7, 10] Cells indicating "No Models" identify those manufacturers who do not market equipment under a specific equipment type. Cells indicating "At or Above" identify those manufacturers who market a complete line of equipment in a wide range of cooling capacities that are at or above the ASHRAE Standard 90.1-1999 minimum efficiency levels. Cells indicating "Below" identify those manufacturers whose equipment are below the ASHRAE Standard 90.1-1999 efficiency levels.

Table 3.7.3 Compliance with ASHRAE Standard 90.1-1999 levels for the ≥65,000 to <135,000 Btu/h Cooling Capacity Range: Major Manufacturers

	AAON	Carrier	Lennox	Trane	Rheem	York
Split System Air Cooled Condensing Unit, Coil with Blower	No Models	At or Above	Not Enough Information*	At or Above	At or Above	Below
Year-Round Single Package Air Conditioner, Air Cooled	At or Above	At or Above	At or Above	At or Above	At or Above	At or Above
Single Package Air Conditioner, Air Cooled	At or Above	At or Above	At or Above	At or Above	No Models	At or Above
Split System Heat Pump with Remote Outdoor Unit Air Source	No Models	Below (small capacity units <90kBtu/h)	Below (six products with EER of 9.2 to 9.4)	At or Above	Below (models with capacities of 92 and 117 kBtu/h have EER of 9.2)	No Models
Single Package Heat Pump Air Source	No Models	Below (small capacity units <90kBtu/h)	At or Above (two products comply)	At or Above	Below (models with capacities of 92 and 118 kBtu/h have EER of 9.2)	At or Above

* Lennox markets four products with an EER of 10.2. Two of the models have horizontal blowers, while the other two have vertical blowers. Lennox literature does not state whether or not the heating section was assembled on the indoor blower when product was tested. For this reason, it was not possible to conclude whether or not the product complies with minimum efficiencies per ASHRAE Standard 90.1-1999. In conclusion, four products marketed under different brands seem to be actually one small size, basic model with a vertical or horizontal blower.

Table 3.7.4 Compliance with ASHRAE Standard 90.1-1999 Levels for Equipment in the ≥135,000 to < 240,000 Btu/h Cooling Capacity Range: Major Manufacturers

	AAON	Carrier	Lennox	Trane	Rheem	York
Split System Air-Cooled Condensing Unit, Coil with Blower	No Models	Below [2]	Below [5]	At or Above	Below	Below
Year-Round Single-Package Air-Conditioner, Air-Cooled	At or Above	Below [3]	Below [6]	Below [8]	Below [9]	Below [10]
Single-Package Air-Conditioner, Air-Cooled	Below [1]	Below [4]	Below [7]	At or Above	No Models	Below [11]
Split System Heat Pump with Remote Outdoor Unit Air-Source	No Models	Below	No Models	At or Above	No Models	Below
Single-Package Heat Pump Air-Source	No Models	At or Above	At or Above	At or Above	No Models	Below [12]

[1] AAON markets a large number of products with a wide range of capacities; all but three models comply.
[2] Carrier markets the same 11 basic models under each of two brand names. Only three of the 11 models comply in the EER range of 9.8 to 10.0.
[3] Carrier markets a large number of products with a wide range of capacities; only 10 of 17 basic models comply.
[4] Carrier markets a large number of products with a wide range of capacities; only 10 of 17 basic models comply.
[5] Lennox markets seven models under two brands; the Lennox brand is the only one that complies.
[6] Lennox markets a large number of products with a wide range of capacities; only four models, from the Lennox brand, comply with EERs in the range of 10.0 to 11.5.
[7] Lennox markets a large number of products with a wide range of capacities; only four models, from the Lennox brand, comply with EERs in the range of 9.9 to 11.5.
[8] Trane markets fifteen basic models with a wide range of capacities; two-thirds of the units comply.
[9] Rheem markets six basic models with a wide range of capacities; only half of the models comply.
[10] York markets a large number of products with a wide range of capacities; only three models from different brands comply with EERs in the range of 9.5 to 10.0.
[11] York markets a large number of products with a wide range of capacities; only three models from different brands comply with EERs in the range of 9.7 to 10.0.
[12] York markets three models under two brand names; one model under one brand name complies.

Small manufacturers for the two major capacity categories covered by this rulemaking of ≥65,000 Btu/h to <135,000 Btu/h and ≥135,000 Btu/h to <240,000 Btu/h, have their own particular equipment and efficiencies per the January 2002 ARI *Unitary Large Equipment Directory*. A short summary for each manufacturer is presented below:

- Bard Manufacturing Company markets two SP-A models in the lower capacity category, both with an EER of 9.0, with basic capacities of 67,000 Btu/h and 68,000 Btu/h.

- Goettl Air-Conditioning, Inc., markets commercial unitary air-conditioning equipment models HSP-A and SP-A in a wide range of sizes (65,000 Btu/h to 120,000 Btu/h) for the lower capacity category.

- Goodman Manufacturing Company markets commercial unitary air-conditioning equipment models SP-A, SPY-A, RCU-A-C (Split System: Air Cooled Condensing Unit, Coil Alone), RCUY-A-CB, and HRCU-A-CB in sizes covered under this rulemaking. None of the models complies with ASHRAE Standard 90.1-1999 standard; models meet the minimum 1992 EPCA efficiency level.

- Heat Controller, Inc., makes a wide range of commercial unitary air-conditioning equipment under the Comfort-Aire brand. Among the models are four small SPY-A models under 90,000 Btu/h, a long list of RCU-A-CB (Split System: Condensing Unit, Coil with Blower, Air Cooled) equipment in both capacity categories, and RCU-A-C (no blower included) equipment between sizes of 90,000 Btu/h to 120,000 Btu/h only.

- Mestek, Inc. markets commercial unitary air-conditioning equipment under the name Koldwave. This equipment is unusual or niche equipment. Models are classified under SP-A in the ARI directory for capacities in the 92,000 Btu/h to 160,000 Btu/h range. None of the models complies with ASHRAE Standard 90.1-1999 levels and have very low integrated part-load values (IPLV) of 6.3 to 7.2.

- Modine Manufacturing Company markets a large amount of commercial unitary air-conditioning equipment over a wide range of sizes in the 65,000 Btu/h to <135,000 Btu/h category. Equipment in this category complies with ASHRAE Standard 90.1-1999 standards. Modine also manufactures some equipment sized at 142,000 Btu/h, which does not comply with ASHRAE Standard 90.1-1999 levels.

- Nordyne, Inc. markets SP-A models of commercial unitary air-conditioning equipment in two basic sizes (90,000 Btu/h and 120,000 Btu/h) under Frigidaire, Nordyne, Philco, and Tappan brands, among others. None of the equipment complies with ASHRAE standards, but models meet the minimum efficiency levels set by EPCA in 1992.

The large number of models listed for each parent company in the ARI database may be the result of similar models manufactured under different "brands," or manufactured with relatively superficial design changes around a base model. To estimate the actual number of these, there is a technique that clusters models with a unique combination of values for a specific list of engineering parameters. Table 3.7.5 shows the selected parameters.

Table 3.7.5 Parameters Used in Algorithm to Identify Base Models from Jan. 2002 ARI Data

ARI Directory Parameter Name	Parameter Description
ARI MFR Name	Manufacturer name
aritype	Equipment category (e.g., SPY-A)
chcap	High cooling capacity (kBtu/h)
cheer	High cooling energy efficiency ratio
iplv	Integrated part load value
hhcap	High heating capacity (kBtu/h)
hlcap	Low heating capacity (kBtu/h)
hhcop	High heating coefficient of performance
hlcop	Low heating coefficient of performance

Results from this query showed several clusters composed of a number of models with equal values for the parameters for a specific manufacturer under a specific equipment category. Each cluster of models counts as one base model. Table 3.7.6 presents the results of this analysis and the number of these "base models."

Table 3.7.6 Manufacturer Base Models and ASHRAE Standard 90.1-1999 Compliance

Source:	January 2002 ARI Large Unitary Equipment Directory

High	Meets 90.1-1999
Low	Below 90.1-1999

	ARI Designation	SP-A		SPY-A		RCU-A-CB		HSP-A		HRCU-A-CB	
	Cooling Capacity Range (kBtu/h)	65 to 135	135 to 240	65 to 135	135 to 240	65 to 135	135 to 240	65 to 135	135 to 240	65 to 135	135 to 240
AAON	High	18	33	20	22	0	0	0	0	0	0
	Low	7	2	8	0	0	0	0	0	0	0
CARRIER	High	7	10	7	11	28	3	2	3	0	0
	Low	6	8	6	9	30	9	9	0	3	1
LENNOX	High	6	4	6	4	0	2	3	4	0	0
	Low	7	7	8	7	13	5	1	0	4	0
RHEEM	High	0	0	4	3	2	0	0	0	0	0
	Low	0	0	7	3	25	10	2	0	2	0
TRANE	High	14	7	10	13	29	4	4	7	19	2
	Low	12	0	17	3	63	0	6	0	32	0
YORK	High	4	3	4	6	0	0	2	1	0	0
	Low	10	14	10	4	9	5	2	2	3	2

NOTE: Numbers inside cells account for number of base models in each category.

ARI Designation Description:	
SP-A	Single Package Air Conditioner, Air Cooled
SPY-A	Year-Round Single Package Air Conditioner, Air Cooled
RCU-A-CB	Split System Air Cooled Condensing Unit, Coil with Blower
HSP-A	Single Package Heat Pump Air Source
HRCU-A-CB	Split System Heat Pump with Remote Outdoor Unit Air Source

ASHRAE 90.1-1999 Minimum Efficiency Levels

kBtu/h	65 to 135	135 to 240
SP-A	10.3	9.7
SPY-A	10.1	9.5
RCU-A-CB	10.3	9.7
HSP-A	10.1	9.3
HRCU-A-CB	10.1	9.3

3.7.4 Other Efficiency Descriptors (COP, IPLV)

Heating coefficient of performance (COP) is a required performance parameter for heat pump equipment covered under this rulemaking. While cooling efficiency, i.e., energy efficiency ratio (EER), is the prime criterion for regulation of this equipment, heat pump heating performance will also be regulated under this rulemaking. Only high temperature (47°F) COP is currently regulated under EPCA. However, ASHRAE Standards 90.1-1999 and 90.1-2001 list both high temperature and low temperature (17°F) COP values. Either or both efficiency criteria could form the basis of DOE's regulation.

Figures 3.7.1 and 3.7.2 show scatter plots of EER compared to high and low temperature heating COP for single package heat pumps (HSP-A) and for split systems (HRCU-A-CB), respectively. ASHRAE Standard 90.1-1999 requires high temperature heating COPs of 3.2 and 3.1 for the ≥65,000 Btu/h to <135,000 Btu/h category and the ≥135,000 Btu/h to <240,000 Btu/h category, respectively. Low temperature COPs are 2.2 and 2.0, respectively, for each size category. Figures 3.7.1 and 3.7.2 show that virtually all heat pumps above an EER of 10.1 meet the high temperature COP requirement. However, only a few appear to meet the low temperature COP requirements. Note that COP appears to be a relatively weak function of EER.

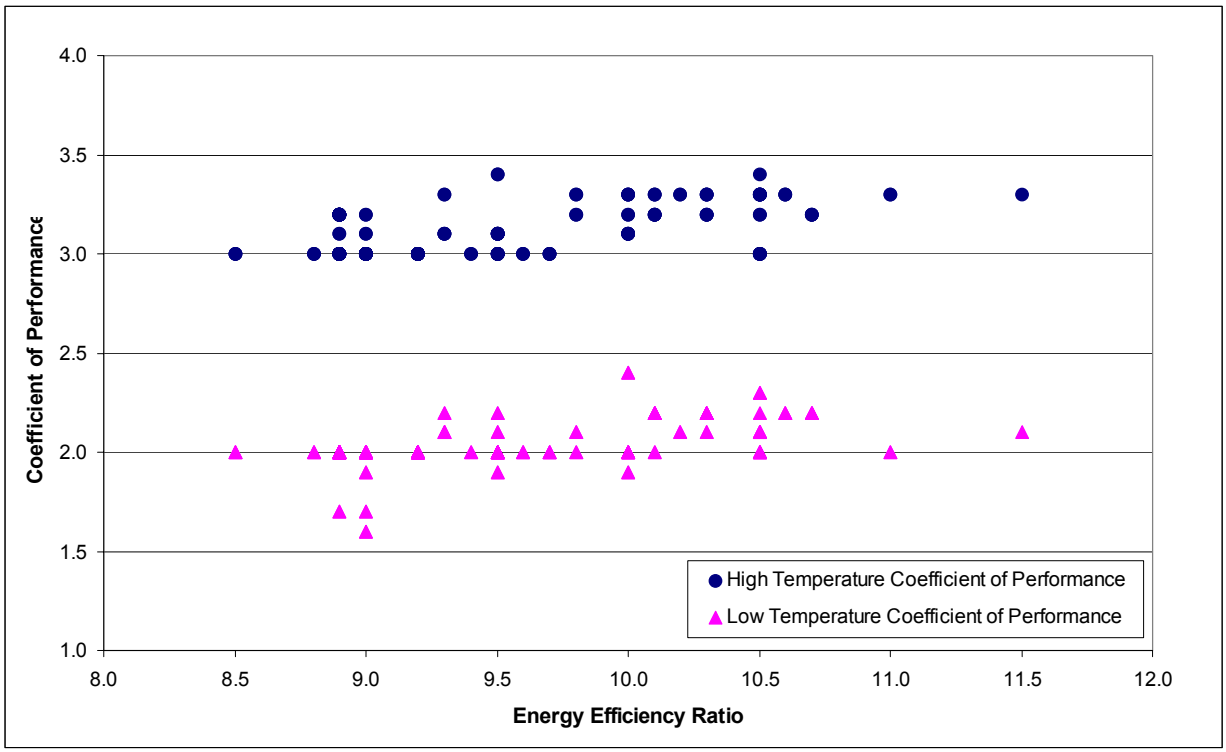

Figure 3.7.1 Heating COP versus EER for Single Package Heat Pump, Air Source (HSP-A), ≥65,000 Btu/h to <240,000 Btu/h Cooling Capacity

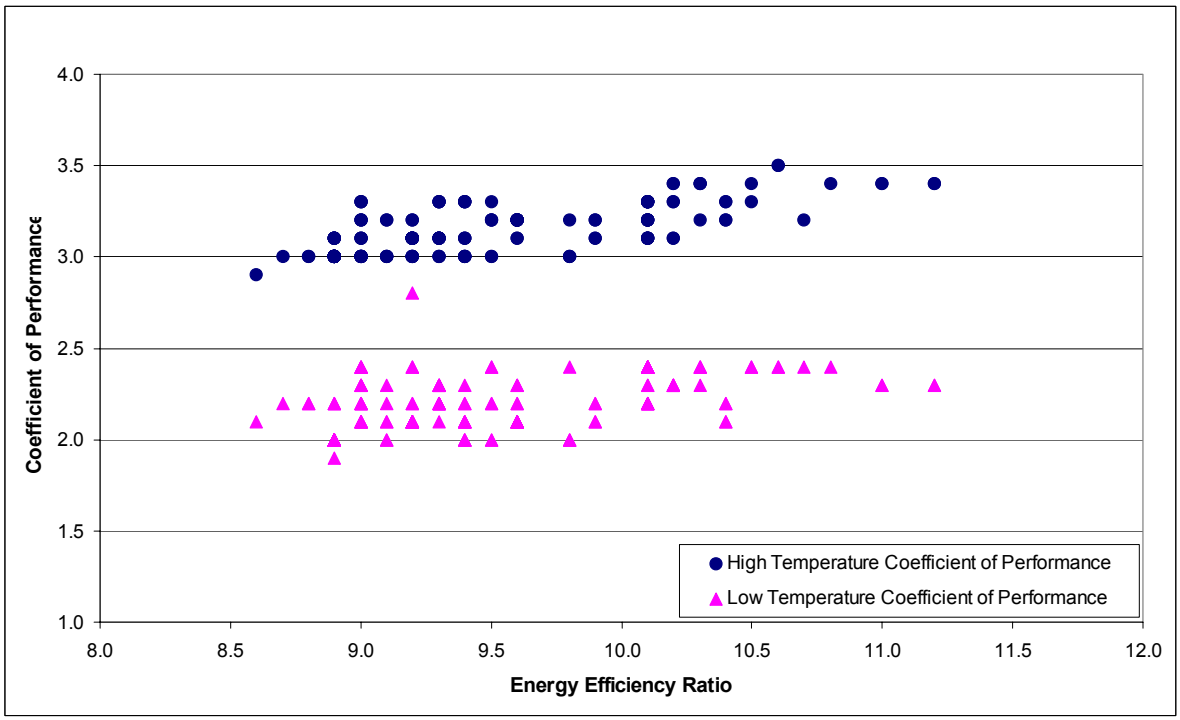

Figure 3.7.2 Heating COP Compared to EER for Split System: Heat Pump with Remote Outdoor Unit, Air Source (HRCH-A-B), ≥65,000 Btu/h to <240,000 Btu/h Cooling Capacity

Integrated part-load value is not regulated for equipment covered under this rulemaking. However, the importance of IPLV (or other measure of part-load performance) cannot be overstated for this equipment, because it strongly relates to actual energy use of commercial unitary air conditioners in real buildings and year-round applications. Figures 3.7.3 and 3.7.4 show IPLV compared to EER for two of the most significant classes of equipment: the year-round single package air conditioners (SPY-A) and split system air conditioners (RCU-A-CB) within the size categories covered by this rulemaking.

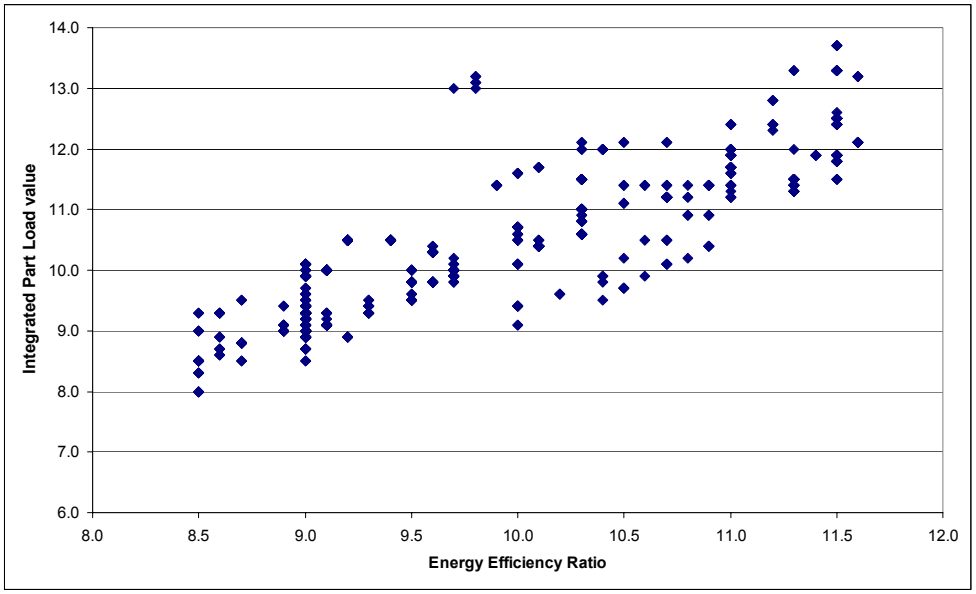

Figure 3.7.3 IPLV Compared to EER for Year-Round Single Package Air Conditioner, Air Cooled (SPY-A), ≥65,000 Btu/h to <240,000 Btu/h Cooling Capacity

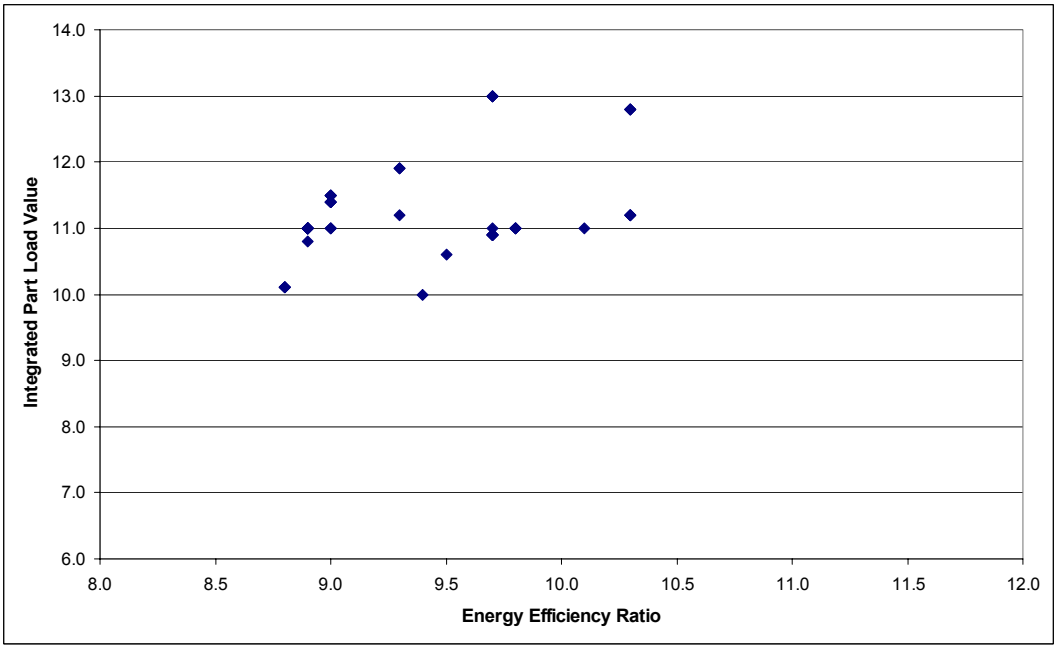

Figure 3.7.4 IPLV Compared to EER for Split System: Condensing Unit, Coil with Blower, Air Cooled (RCU-A-B), ≥65,000 Btu/h to <240,000 Btu/h Cooling Capacity

It is clear that there is a wide range of possible IPLVs for each EER, with some of the highest IPLV ratings occurring for equipment with EERs below ASHRAE Standard 90.1-1999 levels. For single package units with EERs between 10.1 to 11.0 (meeting ASHRAE Standard 90.1-1999 levels), IPLVs range from 1 point below to about 1.7 points above the EER value. The IPLV ratings are not shown for some of the equipment in the ARI Directory. Most of these unreported IPLVs are apparently for single compressor equipment with no unloading capability. Similar patterns comparing IPLV and EER are apparent when comparing single package air conditioners (SP-A), and single package heat pumps (HSP-A).

Far fewer split system air conditioner (RCU-A-CB) IPLVs are shown in the ARI database. Of those listed, the most interesting characteristic is that the split system IPLVs, as a function of EER, start at a somewhat higher level than for the single package air conditioners, with the lowest IPLVs listed starting at about a 10.0 for equipment with a 9.4 or 9.5 EER.

3.8 OTHER FACTS UNDER CONSIDERATION

3.8.1 Single Vertical Package Units

There are certain types of commercial unitary air-conditioning equipment, in particular single package vertical units (SPVU), that are not typical of the mainstream commercial HVAC market. Single package vertical units can be manufactured with a rated cooling capacity of <65,000 Btu/h up to <240,000 Btu/h, and are engineered for wall-mounting on modular buildings. (A majority of this type of equipment have a cooling capacity of less than 65,000 Btu/h and are, therefore, not covered under this rulemaking [12]).

Nevertheless, SPVUs have certain inherent design constraints. The most significant constraint of an SPVU is its small case or enclosure size, because it is designed for a building that cannot accommodate mainstream commercial (rooftop) unitary air conditioner designs, especially in retrofit applications. Features of SPVU equipment include deeper rows of coils (up to five condenser rows and four evaporator rows), a smaller face area, and significantly higher internal fan static pressure and fan power requirements than other mainstream commercial unitary air-conditioning equipment. Also, because the external fan static pressure requirement is relatively low under the DOE test procedure, the impact of high internal fan static pressure of an SPVU is exaggerated when compared with the internal fan static pressure in the mainstream (non-space-constrained) commercial unitary air-conditioning equipment.[12]

Furthermore, the ARI Standard 390-2001 (Single Package Vertical Air-Conditioners and Heat Pumps) establishes testing and rating requirements for SPVUs where the equipment components are vertically oriented, instead of horizontally oriented, as in mainstream commercial unitary equipment.

This market assessment acknowledges the availability of single package vertical units of all cooling capacities. However, because of the above design and test procedure considerations, the Department intends to address SPVUs in a separate rulemaking.

3.8.2 Other Specialized Equipment

There are several manufacturers who appear to specialize in low-volume production of single package or split system equipment for specialized applications. These units generally have more customer-specific features on a baseline model. For example, there are single package or split system air-conditioning units that provide very precise climate control both in temperature and humidity ratio for applications like in computer rooms, specialized laboratory spaces or hospitals. There are five domestic manufacturers of this type of equipment (Liebert Corporation; Data Aire, Inc.; Stulz Air Technology Systems, Inc.; Air-Flow Technology, Inc.; and Compu-Aire, Inc.). A 1998 National Institute of Standards and Technology (NIST) review showed that, while most of these units currently meet the EPCA standards, as amended by EPAct (1992) energy efficiency requirements, their manufacturers have stated that meeting ASHRAE 90.1-1999 efficiency levels will require significant design modifications and increased equipment cost. Therefore, NIST recommended not including computer room air conditioners, when they are used primarily for cooling computers, in this rulemaking.

3.8.3 Impact of Roof Curb in Replacement Design for Single Package Systems

The majority of single package air conditioners and heat pumps are mounted in roof top applications. This typically requires the use of a roof curb. A curb incorporated within the roof serves as a support structure for the unit. The roof curb typically provides an opening for connecting the supply and return duct systems within the building to the roof-mounted package unit. The curb elevates the air conditioner above the roof and provides a means of flashing the curb to prevent water leakage into the space below. Curbs may be either manufactured metal units or site built. Site-built units are typically a simple platform used with horizontally ducted units.

Many of the specific design features used to increase the efficiency of air conditioners and heat pumps result in larger and heavier units. Chief among these features that can add weight are greater coil surface area and the number of rows of coils on both the evaporator and the condenser heat exchangers. Higher-efficiency rooftop applications may entail additional costs for curb design. This may be an important issue in retrofit applications. If new unitary equipment is significantly heavier than the equipment it is replacing, the additional weight may require replacement or modification of an existing roof curb.

To work around this issue, a manufacturer may choose to modify component or material choices to minimize any increase in weight for the higher-efficiency equipment. However, there are limits to accomplishing this. In developing higher-efficiency equipment, manufacturers consider the effect of significant increases in weight on installation costs. An example would be the need for a helicopter rather than a crane to carry and position units.

A significant increase in the sizes of new units may also impact replacement installation costs, but this is generally less of an issue than weight. While there may be isolated instances of larger roof top units physically bumping into other roof equipment during installation, this should rarely occur because sound design practice provides extra space around units for maintenance access and air flow. There may be concerns with new downflow units requiring new roof curbs because the new units may not align with existing roof curbs. However, some

manufacturers specifically design their new high-efficiency equipment to fit existing roof curbs.[13] If manufacturer designs for higher-efficiency equipment cannot accomplish this, there are a number of companies who manufacture transition curbs to mate new package units to existing curbs. However, this option would likely increase installation costs.

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